

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS

1. An isolated and purified polynucleotide encoding a cytochrome P-450 reductase enzyme from an alkaloid poppy plant, or a variant, fragment or analog thereof.
- 5 2. A polynucleotide according to claim 1, selected from the group consisting of genomic DNA, cDNA, or synthetic DNA.
3. A polynucleotide according to claim ~~1 or claim~~ 2, selected from the group consisting of:
- (a) the polynucleotide sequences set out in Figures 6, 9 or 10; and
- 10 (b) complementary sequences of the polynucleotide sequences which hybridize under stringent conditions to the polynucleotide sequences defined in (a).
4. A polynucleotide according to ~~any one of the preceding claims~~ ^{claim 3}, lacking the native leader sequences or any of the 5' or 3' untranslated regions of the polynucleotide.
5. A polynucleotide according to claim 4, wherein the native leader sequences or
- 15 any of the 5' or 3' untranslated regions are replaced with exogenous control/regulatory sequences which regulate optimised/enhanced expression of the polynucleotide in an expression system.
6. A polynucleotide according to any one of the preceding claims which encodes cytochrome P-450 reductase enzyme of *Papaver somniferum* or *Eschscholzia*
- 20 *californica*.
7. A polynucleotide according to claim 6 which encodes cytochrome P-450 reductase enzyme of *Papaver somniferum*.
8. A polynucleotide according to claim 6 which encodes cytochrome P-450 reductase enzyme of *Eschscholzia californica*.
- 25 9. A polynucleotide according to ~~any one of claims 2 to 8~~ ^{claim 3}, which is a synthetic polynucleotide comprising one or more codons preferred for expression in plant cells.
10. An isolated and purified polynucleotide which codes for prokaryotic or eukaryotic expression of a cytochrome P-450 reductase enzyme from an alkaloid poppy plant, or a variant, analog or fragment thereof, wherein the polynucleotide is expressed
- 30 in an environment selected from the group consisting of the extracellular environment, an intracellular membranous compartment, intracellular cytoplasmic compartment or combinations thereof.

11. A polynucleotide according to claim 10, comprising a nucleotide sequence which directs expression of the cytochrome P-450 reductase enzyme with respect to a particular cellular compartment or the extracellular environment.
12. An isolated and purified polynucleotide having a sequence which is complementary to all or part of the sequence of a polynucleotide according to ~~any one of claims 1 to 11.~~ ^{claim 10}
13. A recombinant DNA construct comprising the polynucleotide according to ~~any one of claims 1 to 12.~~ ^{claim 1}
14. A DNA construct according to claim 13, which is a viral or plasmid vector.
15. A DNA construct according to claim 13 ~~or claim 14,~~ capable of directing prokaryotic or eukaryotic expression of the polynucleotide encoding a cytochrome P-450 reductase enzyme.
16. A DNA construct according to ~~any one of claims 13 to 15,~~ ^{claim 13} comprising a promoter suitable to control the expression of the polynucleotide.
17. A DNA construct according to claim 16, wherein the promoter is endogenous.
18. A DNA construct according to claim 16, wherein the promoter is derived from cauliflower mosaic virus or subterranean clover mosaic virus.
19. An isolated and purified cytochrome P-450 reductase enzyme, being a product of prokaryotic or eukaryotic expression of the polynucleotide of ~~any one of claims 1 to 11 or a DNA construct of any one of claims 13 to 18.~~ ^{claim 1}
20. An enzyme according to claim 19, being a product of yeast cell expression.
21. An enzyme according to claim 19, being a product of bacterial cell expression.
22. An enzyme according to claim 19, being a product of animal cell expression.
23. An enzyme according to claim 22, being a product of insect cell expression,
24. An enzyme according to claim 19, being a product of plant cell expression.
25. An enzyme according to claim 24, wherein the plant cell is an alkaloid poppy plant cell.
26. An enzyme according to claim 25, wherein the alkaloid poppy is *Papaver somniferum*
27. An enzyme according to claim 25, wherein the alkaloid poppy is *Eschscholzia californica*.
28. An enzyme according to ~~any one of claims 19 to 27,~~ ^{claim 19} which is a variant incorporating amino acid deletions, substitutions, additions or combinations thereof, wherein the variant retains one or more of the biological properties of cytochrome P-450

reductase enzyme.

29. A cell transformed or transfected with a polynucleotide according to ~~any one of claims 1 to 11 or a DNA construct according to any one of claims 13 to 18.~~ ^{claim 1}
30. A cell according to claim 29, which is a plant cell.
- 5 31. A cell according to claim 30, wherein the plant cell is derived from an alkaloid poppy plant.
32. A cell according to claim 31, wherein the poppy plant is *Papaver somniferum*
33. A cell according to claim 31, wherein the poppy plant is *Eschscholzia californica*.
- 10 34. A cell according to claim 29, which is a bacterial cell.
35. A cell according to claim 29, which is an animal cell.
36. A cell according to claim 29, which is a yeast cell.
37. A callus transformed or transfected with a polynucleotide according to ~~any one of claims 1 to 11 or a DNA construct according to any one of claims 13 to 18.~~ ^{claim 13}
- 15 38. A plant transformed or transfected with a polynucleotide according to ~~any one of claims 1 to 11 or a DNA construct according to any one of claims 13 to 18,~~ ^{claim 13} wherein the plant exhibits altered expression of the cytochrome P-450 reductase enzyme.
39. A plant according to claim 38, wherein the altered expression is overexpression of the cytochrome P-450 reductase enzyme.
- 20 40. A plant according to claim 38, wherein the altered expression is reduced expression of the cytochrome P-450 reductase enzyme.
41. A plant according to any one of ~~claims 38 to 40,~~ ^{claim 38} which is an alkaloid poppy plant.
42. A plant according to claim 41, wherein the plant has a higher or different alkaloid
- 25 content when compared to a plant which has not been so transformed or transfected.
43. A plant according to claim 41 ~~or claim 42,~~ wherein the alkaloid poppy plant is *Papaver somniferum*.
44. A plant according to claim 41 ~~or claim 42,~~ wherein the alkaloid poppy plant is *Eschscholzia californica*.
- 30 45. A method for preparing plants which overexpress a cytochrome P-450 reductase enzyme, comprising transfecting or transforming a plant cell, a plant part or a plant with the polynucleotide according to ~~any one of claims 1 to 11 or a DNA construct according to any one of claims 13 to 18.~~ ^{claim 1}
46. A method according to claim 45, wherein the plant is an alkaloid poppy plant.

47. A method according to claim 46, wherein the poppy plant is *Papaver somniferum*.
48. A method according to claim 46, wherein the poppy plant is *Eschscholzia californica*.
- 5 ~~49~~. A method of altering the yield or type of alkaloid in a plant comprising transforming or transfecting a plant cell, a plant part or a plant with a polynucleotide encoding a cytochrome P-450 reductase enzyme or a variant, analog or fragment thereof, or with a polynucleotide which binds under stringent conditions to the polynucleotide encoding said enzyme.
- 10 ~~50~~. A method of increasing the yield of alkaloid in a plant comprising transforming or transfecting a plant cell, a plant part or a plant with a polynucleotide encoding a cytochrome P-450 reductase enzyme or a variant, analog or fragment thereof, wherein the enzyme is overexpressed in said plant.
- ~~51~~. A method of altering type or blend of alkaloid in a plant comprising transforming or transfecting a plant cell, a plant part or a plant with a polynucleotide encoding a cytochrome P-450 reductase enzyme or a variant, analog or fragment thereof, or with a polynucleotide which binds under stringent conditions to the polynucleotide encoding said enzyme.
- 15 52. A stand of stably reproducing alkaloid poppies transformed or transfected with a polynucleotide according to ~~any one of claims 1 to 11 or a DNA construct according to any one of claims 13 to 18~~, having altered expression of the cytochrome P-450 reductase enzyme.
- 20 53. A stand of stably reproducing alkaloid poppies transformed or transfected with a polynucleotide according to ~~any one of claims 1 to 11 or a DNA construct according to any one of claims 13 to 18~~, having a higher or different alkaloid content when compared to a plant which has not been so transformed or transfected.
- 25 54. A stand of stably reproducing alkaloid poppies according to claim 52 ~~or claim 53~~, wherein the alkaloid poppy is *Papaver somniferum*.
55. Straw of stably reproducing poppies according to ~~any one of claims 52 to 54~~, having a higher or different alkaloid content when compared to the straw obtained from an alkaloid poppy which has not been transformed or transfected.
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56. A concentrate of straw according to claim 55, having a higher or different alkaloid content when compared to the concentrate of straw obtained from an alkaloid poppy which has not been transformed or transfected.

57. An alkaloid when isolated from the straw according to ^{claim 52} ~~any one of claims 52 to 55~~
5 ~~or the concentrate according to claim 56.~~

58. An alkaloid according to claim 57 selected from the group consisting of morphine, codeine, oripavine and thebaine.

59. A method for the production of poppy plant alkaloids, comprising the steps of;

a) harvesting capsules of an alkaloid poppy plant transformed or transfected
10 with a polynucleotide according to ^{claim 1} ~~any one of claims 1 to 12 or a DNA construct~~
~~according to any one of claims 13 to 18~~, to produce a straw where the poppy plant is
such a plant that the straw has a higher or different alkaloid content when compared to
the straw obtained from a poppy plant which has not been transformed or transfected.

b) chemically extracting the alkaloids from the straw.

15 60. A method for the production of poppy alkaloids comprising the steps of;

a) collecting and drying the latex of the immature capsules of an alkaloid
poppy plant transformed or transfected with a polynucleotide according to ^{claim 1} ~~any one of~~
~~claims 1 to 12 or a DNA construct according to any one of claims 13 to 18~~, to produce
20 opium where the poppy plant is such a plant that the opium has a higher or different
alkaloid content when compared to the opium obtained from a poppy plant which has
not been transformed or transfected.

b) chemically extracting the alkaloids from the opium.

61. A method according to claim 59 ~~or claim 60~~, wherein the alkaloid is selected from
the group consisting of morphine, codeine, oripavine and thebaine.

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